

A NEW SPECIES OF *ZIGADENUS* (LILIACEAE)  
FROM NEW MEXICO, WITH ADDITIONAL  
COMMENTS ON THE SECTION *ANTICLEA*

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ABSTRACT

A new species, *Zigadenus mogollonensis*, is described and illustrated. Its large flowers are campanulate, cernuous, and have a distinct purplish tinge. It is endemic, but quite locally common, to the Mogollon Mountains of southwestern New Mexico. A discussion on related species characteristics and variation within the section *Anticlea* of the genus *Zigadenus* is also presented.

RESUMEN

Se describe e ilustra una nueva especie, *Zigadenus mogollonensis*. Sus flores grandes son campanuladas, colgantes y tienen un tinte púrpura manifiesto. Es endémica, aunque muy común localmente, de las montañas Mogollon del Suroeste de Nuevo México. Se ofrece también una discusión de las características y variación en las especies emparentadas dentro de la sección *Anticlea* del género *Zigadenus*.

In 1968, Hess collected a *Zigadenus* from the interior of the Mogollon Mountains in southwestern New Mexico and identified it as *Zigadenus virescens* (Kunth) J.F. Macbr. In the summer of 1993, he returned to the same general area and recollected this plant. Upon becoming familiar with the true *Z. virescens*, it was evident that the original collection was misidentified and that this *Zigadenus* was undescribed. Through inquiry, Hess discovered that Sivinski was also studying this same plant in the Mogollon Mountains, and had independently arrived at the same conclusion that it was a new and undescribed species of *Zigadenus*.



**Zigadenus mogollonensis** Hess & Sivinski, sp. nov. (Fig. 1)

Perennius robustus, (4.5–)5.5–8.5(–9.5) dm altus. Bulbi tenues ovoidei, 2–3 × 1.3–2 cm, tegmento papyraceo tenue vel tegmento crasso fibrarum e basibus foliorum veterum ad 1 dm infra terram. Folia basalia ad 35 cm longa, 10–18 mm lata, margines leviter scabri; folia caulina 1–3(–5) sursum deminuta. Inflorescentiae racemosae (8–)10–21(–28) nodis, 10–25(–35) × 3.5–8 cm, interdum paniculati ramis ex infernis 2–3 nodis. Pedicelli crassi, 1.3–2 cm longi, recurvati sub anthesi, fructificantes erecti; bractae infimae 2–4 × 0.5–1.2 cm, acutae vel acuminatae, pallide virides, saepe tinctae purpurae per longitudinem marginum, longiores pedicellis, interdum extensi trans flores. Flores campanulati et cernui; tepala elliptica, margines saepe recurvi, 12–16 × 7–9.5 mm, rutilantia vel margines rutilantes, virescentes (pallide flavovirentes vel virides) prope venam mediam abaxialem, adaxialem vulgo pallidiores; apices rotundati, aliquando leviter emarginati; gradatim angustati ad basem vel late unguiculati; venae viridulae, arcuatae versus apicem; glandes 5–6.5 × 3.2–5(–6) mm, leviter expansae ad extremitates, apices emarginati vel undulati, aliquantum bilobati, flavovirentes; stamina cum filamentis 7–8 mm longa, dilata basi, 1.5–2 mm lata, decrescentia ad 0.5 mm lata articulo antherarum, antherae 2.4–2.6 × 1.7–2 mm, hippocrepiformia, dehiscentia per totam longitudinem, pollen striatum, monosulcatum 30–42 $\mu$  × 18–24 $\mu$ ; pistilla tricarpellata, ovaria partim inferiora, trilocularia, 3 styli et stigmata; ovula numerosa, plana, breviter lanceolata. Capsulae trilobatae, 12–15 mm longae, lobi tepalae orientes 4–5 mm super pedicellos; nulla semina observata.

Robust perennials, (4.5–)5.5–8.5(–9.5) dm tall. Bulbs slender, ovoid, 2–3 × 1.3–2 cm, with thin, papery covering to thick, fibrous covering from old leaf bases, to 1 dm below ground. Basal leaves to 35 cm long, 10–18 mm wide, margins slightly scabrous; cauline leaves 1–3(–5), reduced upwards. Inflorescences racemose, with (8–)10–21(–28) nodes, 10–25(–35) × 3.5–8 cm, occasionally paniculate with branches from lower 2 or 3 nodes. Pedicels stout, 1.3–2 cm long, recurved at anthesis, erect in fruit; lowest bracts 2–4 × 0.5–1.2 cm, acute to acuminate, pale green, often purple-tinged along the margins, longer than pedicels, occasionally extending beyond the flowers. Flowers campanulate and cernuous; tepals elliptic to broadly elliptic, the margins often arching inward, 12–16 × 7–9.5 mm, purplish-red or margins purplish-red blending to pale yellow-green or green near midvein abaxial side, mostly lighter colored adaxial side; apices rounded, occasionally slightly emarginate; gradually tapering to base or broadly clawed; veins greenish, arching towards apex; glands 5–6.5 × 3.2–5(–6) mm, slightly expanded terminally, apices emarginate or undulate, somewhat bilobed, greenish-yellow; stamens with filaments 7–8 mm long, dilated at base, 1.5–2 mm wide, tapering to 0.5 mm wide at anther connection, anthers 2.4–2.6 × 1.7–2 mm, horseshoe-shaped, dehiscing entire length, pollen striate, monosulcate, 30–42 $\mu$  × 18–24 $\mu$ ; pistil tricarpellate, ovary partially inferior, trilocular, 3 styles and stigmata; ovules many, flat, short lanceolate. Capsules 3-lobed, 12–15 mm long, tepal lobes originating 4–5 mm above pedicels; no seeds seen. Flowering late August to early September. Fruiting September.





FIG. 1. *Zigadenus mogollonensis*. A. Habit. B. Flower with outline of glands on tepals. C. Flower and bract. D. Pendulous flowers



TYPE: U.S.A. NEW MEXICO. Catron Co.: Mogollon Mts., of the Gila Wilderness, Gila National Forest, vicinity of Mogollon Baldy, Whitewater Baldy, Black and Sacaton Mts., on Little Dry Creek Trail from Apache Springs, elev. 2860 m, 20 Aug 1968, *W. Hess 2212* (HOLOTYPE: MOR; ISOTYPES: ARIZ; NCU; NMC; NY; OKLA; SMU; US).

Additional collections examined: U.S.A. NEW MEXICO. Catron Co.: Mogollon Mts., S of Whitewater Baldy, center of sect. 30, T11S R18W, elev. 3140 m, understory of dense, mature forest, 9 Sep 1980, *R. Fletcher 4856* (UNM); 15 mi NE of Mogollon, 1 Aug 1938, *C.L. Hitchcock, R.V. Retbke, R. van Raadschooven 4463* (WTU); along Bursum Road E of Mogollon, T11S R18W sect. 3, elev. 2770 m, 19 Jul 1994, *C.A. Huff 1660* (UNM); between Apache Cabin & Sacaton, Baldy, Mogollon Mts., 9000 ft, 20 Jul 1959, *A.R. Kruckeberg 4671* (WTU; UC); Gila Forest Trail 182, ca. 2.5 km S of NM 78, T11S R18W sections 2 and 11, elev. 3050 m, 2 Aug 1987, *G.A. Levin 1909* (NMC); Gila Wilderness, Whitewater Baldy, spruce-fir forest with *Vaccinium myrtillus* and *Rubus parviflorus*, infrequent, elev. 3020 m, 2 Aug 1974, *W.H. Moir 315* (NMC; RM); Mogollon Mts., Forest Trail No. 182, Sandy Point, first 2 mi, ponderosa pine-aspen forest, 15 Aug 1974, *D. Pinkava, E. Lehto & T. Reeves P12558* (ARIZ; WTU); Gila National Wilderness, Mogollon Mts., ca 10 air mi ESE of Mogollon and 1 mi from Hwy 78 on Trail 206 to Redstone Park, on W-slope, soil rocky clay with humus, *Populus tremuloides*, *Pteridium*, and *Rubus*, elev. 2680 m, 5 Sep 1976, *J. Reitzel, D. Hill & R. Spellenberg 33* (NMC); Mogollon Mts., Forest Service Road 159 between Silver Creek Divide and Sandy Point, T11S R18W sect. 3 SW  $\frac{1}{4}$ , on rhyolitic soil, N-facing slope in understory of mixed conifer forest of *Pseudotsuga menziesii*, *Abies concolor*, *Acer glabrum*, *Geranium richardsonii*, *Viola canadensis*, elev. 2800 m, 12 Aug 1993, *R. Sivinski & K. Lightfoot 2517* (MOR, UNM); on NM Hwy 78 between Mogollon and Beaverhead, T11S R18W sect. 2 SW  $\frac{1}{4}$ , with spruce, fir, limberpine, aspen, thimbleberry, *Geranium*, *Cornus*, *Oxalis*, *Senecio cardamine*, elev. 2770 m, 16 Aug 1985, *R. Spellenberg & N. Zucker 8237* (NMC); Mogollon Mts., Mogollon Road, 8 Aug 1900, *E.O. Wootton s.n.* (US).

*Zigadenus mogollonensis* is apparently endemic to the mixed conifer and spruce-fir forests of the Mogollon Mountains between 2650 and 3200 meters in elevation. It is a common understory component of these high elevation forests and usually occurs on highly organic soils with a thick humus layer. Variation within this species is represented by its completely racemose or branched lower inflorescence, its range of tepal lengths between 12 and 16 mm, and corolla pigmentation of pale yellowish-green with pale purple margins to green with dark brownish-purple margins. The exceptional specimen of *Reitzel et al. 33* (NMC) has green tepals with only little anthocyanic pigmentation, and is here placed within *Z. mogollonensis* because of its long (13 mm) tepals and campanulate corolla. Previous collectors have usually identified this species as *Z. virescens*, but also as *Z. elegans* Pursh and *Z. porrifolius* Greene.

The nearest related species to *Zigadenus mogollonensis* are *Z. elegans* and *Z. virescens*. Both are widespread species, with *Z. elegans* ranging from Alaska to northern Mexico and *Z. virescens* occurring in the Sierra Madres of Mexico north to the southern mountains of Arizona and New Mexico. *Zigadenus mogollonensis* and *Z. elegans* have a similar inflorescence, which is usually racemose, but can have one or few lower paniced inflorescence branches.



Rotate to rotate-campanulate corollas, erect pedicels at anthesis, and shorter (5–10 mm) tepals are characteristics of *Z. elegans*, whereas *Z. mogollonensis* is distinguished by its campanulate corollas, cernuous flowers at anthesis, and longer (12–16 mm) tepals. *Zigadenus virescens* is a more delicate plant with thinner pedicels and panicle branches, shorter bracts (usually less than the length of the pedicel), small (4–7 mm) tepals, campanulate corollas, and recurved pedicels at anthesis. *Zigadenus mogollonensis* has more robust pedicels and branches, larger bracts (as long or longer than the pedicels) and much larger tepals. The anterior margins of its tepals are also suffused with anthocyanic red over yellowish-green, which gives the flower a brownish-purple appearance. Both *Z. elegans* and *Z. virescens* frequently have anthocyanic bracts; however, this pigmentation infrequently extends to the flowers, and then is confined to the base of the tepals on the abaxial surface. Their open flowers are white, ochroleucous, or pale green. The references to purplish-flowered *Z. elegans* in western American floras (Correll & Johnston 1970; Harrington 1964) are overstated and apparently derived from the description of purplish tepals for *Z. coloradensis* Rydberg (1900), which is a synonym of *Z. elegans*. The type specimen of *Z. coloradensis* is white-flowered, with small amounts of anthocyanic pigment on the abaxial surface of the tepals. The purplish pigmentation of *Z. mogollonensis* is much more intense and colors the anterior margins of the tepals.

*Zigadenus elegans* is very rare in the Mogollon Mountains of New Mexico and is known from that range by a single 1881 collection (*Rusby 406 US*, only the flowering plant on sheet). However, *Z. elegans* is more common in the adjacent White Mountains of eastern Arizona and northern mountain ranges of Arizona and New Mexico. *Zigadenus virescens* is common in the Mogollon Mountains and occurs with *Z. mogollonensis* on the same forested slopes near Silver Creek Divide. No evidence of hybridization was observed at this point of sympatry. Pollen samples from four *Z. mogollonensis* and two adjacent *Z. virescens* were tested with Alexander's stain and found to be 99–100% viable. Late summer flowering times here are somewhat overlapped, but most *Z. virescens* flowered a little earlier and produced fruit at the time *Z. mogollonensis* was in full flower. A few unusual specimens of *Z. virescens* from the northern Mogollon Mountains (*Daniel & Nelson 3598 ASU*; *Hubbard s.n. UNM*) have large, leafy bracts that could possibly indicate a past crossing event with *Z. mogollonensis*.

*Zigadenus mogollonensis* appears most similar to the large-flowered forms of *Z. volcanicus* Benth. in the Sierra de los Cuchumatanes in the Huehuetenango district of western Guatemala. These two populations have long tepals, large bracts, cernuous/campanulate flowers and thick pedicels. They are differentiated by the somewhat larger, purple tepals of *Z. mogollonensis* compared to the white to ochroleucous tepals of the plants in Guatemala.



ADDITIONAL COMMENTS ON SECTION *ANTICLEA*

The above species belong to the section *Anticlea* of the genus *Zigadenus*, which is characterized by a single bilobate or obcordate gland at the base of each tepal and a partially inferior ovary. Preece (1956) recognized five American taxa (*Z. elegans* var. *elegans*, *Z. elegans* var. *glaucus* (Nutt.) Preece, *Z. virescens*, *Z. vaginatus* (Rydb.) J.F. Macbr., *Z. volcanicus*) in this section with one, or possibly two, additional species in Asia. Turner (1992) recently added another Mexican species (*Z. hintoniorum* B.L. Turner) to the section *Anticlea*. The species of this section are usually distinct, but among the taxa intergradations and inconsistent variations are common. Species diagnosis must often rely on a combination of descriptive, qualitative features rather than definitive, measurable characteristics. Species descriptions that do not account for the range of variation have made this genus misunderstood, and is evidenced by a long list of synonymy and the questionable rank of a few taxa. After studying the types and several hundred specimen sheets, the following discussion attempts to clarify some of the morphological tendencies of the American taxa in the section *Anticlea* of *Zigadenus*.

The two most important characteristics in separating taxa in the section *Anticlea* are the position of the flower (erect or nodding) and flower shape (rotate or campanulate). The flowers at anthesis are either on erect pedicels with perianth widely spreading or rotate-campanulate, or cernuous pedicels with perianth consistently campanulate. Unfortunately, these characteristics are often difficult to assess on pressed and dried specimens, and collectors are well advised to note the floral aspects of fresh plants. It is also important to assess these characteristics on flowers in anthesis, since taxa with erect flowers can have cernuous buds, while those with nodding flowers will usually become erect in fruit.

Plants with erect/rotate flowers are best represented by the *Zigadenus elegans* complex. This is the common North American species that extends from Alaska and eastern Canada to the southern Rocky Mountains and is sporadic in northern Mexico. It is very polymorphic, but retains some consistency by its erect pedicels and rotate corollas. Its flowers can often be attached to the erect pedicels at an angle that turns the faces of the flowers toward the outside of the inflorescence and perpendicular to its axis. This may give the false appearance of nodding flowers in some pressed specimens. Such minor and inconsistent variation is especially common in the mountains of central New Mexico, but occasionally occurs on specimens from Colorado, Utah, northern Arizona, and Chihuahua. This variant often, but not always, occurs in combination with very large bracts.

The eastern variety, *Zigadenus elegans* var. *glaucus*, and a low elevation species from the canyonlands of western Utah, *Z. vaginatus*, are the only



other erect pedicel-rotate corolla taxa presently recognized. The inflorescence of *Z. vaginatus* is similar to *Z. elegans*, particularly with those variants from central New Mexico that have a perpendicular flower attachment below the calyx. Most flowers of *Z. vaginatus* are often smaller, but within the range of typical *Z. elegans*. Cronquist *et al.* (1977) considered *Z. vaginatus* a synonym of *Z. elegans*. Preece (1956) and Welsh (1989) maintained these taxa as distinct species because the former occurs at lower elevations in hanging garden seeps on canyon walls and has a later flowering period of July through September. *Zigadenus elegans* in Utah and Colorado grows at higher elevations and flowers earlier during June and July. Preece (1956) and Welsh (1989) stated that *Z. vaginatus* is closely related to *Z. volcanicus* in Guatemala. However, we believe it is more closely related to *Z. elegans* because of its erect pedicels and rotate corollas rather than to *Z. volcanicus*, which has cernuous/campanulate flowers. *Zigadenus elegans* also occupies similar habitats and tends to flower later south to the Guadalupe Mountains on the New Mexico/Texas border. A feature unique to *Z. vaginatus* is its numerous hard, persistent leaf bases, which allows it to be separated from *Z. elegans*.

*Zigadenus elegans* is rare in northern Mexico, with a few known locations in Chihuahua and Coahuila. The Mexican populations differ from typical *Z. elegans* and have been treated variously. For instance, there is a large-flowered (tepals  $10 \times 5$  mm long), large-bracted variant with rotate corollas and perpendicular flower attachment on erect pedicels called *Z. mohinorensis* Greenm. Greenman (1903) does not mention flower angle, but it is evident on the type specimen (Nelson 4875 US). Preece (1956) placed *Z. mohinorensis*, known only from a few collections from Mt. Mohinora in Chihuahua, into synonymy with *Z. elegans*, but with some reservation.

*Zigadenus gracilentus* Greene (1901) was described, based on plants collected in the Sierra Madre of Chihuahua (Pringle 1383 F, NY, US) and originally identified as *Z. elegans*. They had campanulate corollas, tepals 6–7 mm long, short stamens, and widely spreading pedicels. Greene described this new species as strictly dioecious and with different tepal characteristics for the staminate and pistillate plants. There is some variation in tepal morphology; however, the types studied for this discussion had obvious stamens and maturing ovaries. Preece (1956) placed *Z. gracilentus* into synonymy with *Z. elegans*. In addition to the campanulate corollas and long, spreading pedicels, the flowers might have been cernuous at anthesis. The inflorescence bracts are narrow, acuminate, and  $2/3$  the length of the pedicels, and are identical to the long, linear-bracted form of *Z. virescens* that is common in the northern Sierra Madres of Chihuahua and Sonora, and the Huachuca Mountains of southern Arizona. *Zigadenus gracilentus* is interme-



diate between *Z. virescens* and *Z. elegans* and cannot be comfortably placed into synonymy with either species. The precise type locality of *Z. gracilentus* is unknown, but if it were to be relocated and the population had plants with consistently erect pedicels and campanulate corollas, it might be worthy of taxonomic recognition.

South of the Rocky Mountains to Guatemala, the dominant form of *Zigadenus* has cernuous/campanulate corollas and is best illustrated by the variable *Z. virescens*. This species occurs predominantly in Mexico and usually characterized by small tepals (4–7 × 1.5–3.5 mm), exerted stamens, short bracts, and slender, recurved pedicels. *Zigadenus volcanicus*, compared to *Z. virescens*, ranges further south into Guatemala and has slightly to greatly larger flowers (tepals 6–15 mm long), included stamens, and broader tepals (3–6 mm). *Zigadenus mogollonensis* is a New Mexico endemic with large purple flowers.

There are many examples of herbarium specimens with inconsistent character combinations for particular species. For instance, intermediate forms between *Z. elegans* and *Z. virescens*, within a fairly broad area of sympatry in eastern Arizona, southwestern New Mexico and northern Mexico, frequently have the tepal measurements, thicker pedicels and somewhat longer bracts of *Z. elegans*, and cernuous/campanulate corollas of *Z. virescens*. They are the dominant form in some localized areas (i.e., Mt. Baldy in the White Mountains of eastern Arizona). They also are in mixed populations since they share the same herbarium sheet with typical *Z. virescens* (i.e., White Mts., AZ, Peebles 12522 ARIZ) or with typical *Z. elegans* (i.e., Mogollon Mts., NM, Rusby 406 US).

Several attempts have been made to recognize taxonomically these scattered, larger-flowered forms of *Zigadenus virescens*. The southwestern New Mexico plants were named *Z. porrifolius* Greene (1881), a name later applied to several collections from eastern Arizona and an aberrant form from southern Coahuila (Hemsley 1885). In 1940, O. S. Walsh annotated many of these specimens as *Z. virescens* var. *porrifolius*, a combination that was never published. Kearney and Peebles (1951) placed *Z. porrifolius* into synonymy with *Z. virescens*, but stated that it might be worthy of varietal status. Preece (1956) placed *Z. porrifolius* in synonymy with *Z. virescens* and attributed its larger flower size to the influence of *Z. elegans*. *Zigadenus porrifolius* is probably not worthy of taxonomic distinction because of its sporadic distribution and mixed populations. However, it is frequent enough to cause difficulties in species determination.

In eastern and southern Mexico, *Z. virescens* may also intergrade with *Z. volcanicus* and possibly *Z. elegans*. There are several collections with long bracts, thick pedicels, and broader tepals of *Z. volcanicus* and *Z. elegans*, but with the distinctly decurved pedicels, campanulate corollas, and longer



stamens of *Z. virescens*. A few larger-flowered collections from the border area between Coahuila and Nuevo Leon strongly resemble *Z. volcanicus*, and the collection (*McDonald 1522 TEX*) from Coahuila could easily be placed within that species. This, and most of the tall forms of *Z. virescens* in eastern Mexico, have recently been named *Z. hintoniorum* (Turner 1992). The holotype of *Z. hintoniorum* is somewhat aberrant, but it and the paratypes are clearly the highly variable species *Z. virescens*. In fact, the broad limits given to *Z. hintoniorum* would include *Z. porrifolius* and almost all of *Z. volcanicus*. Some *Zigadenus* from the Sierra Madre Orientale display odd character combinations that may be taxonomically divisible on a smaller scale; however, *Z. hintoniorum* is not correctly circumscribed and represents another attempt to segregate several intergrading and variable populations that cannot be comfortably assigned to *Z. virescens*, *Z. elegans*, or *Z. volcanicus*.

*Zigadenus volcanicus* is a poorly understood species that has been incorrectly represented by Preece (1956) and Turner (1992). Preece (1956) described *Z. volcanicus* as a short plant (2–3.5 dm) with erect or spreading pedicels and a corolla diameter of 1–1.4 cm, which could only be accurate if the corolla were rotate. However, among the specimens Preece annotated as *Z. volcanicus*, was one 7.5 dm tall (*Seler 2323 US*), and the type specimen (*Hartweg 626 NY*) was cut into several sections to fit on the sheet! These, and all other specimens of *Z. volcanicus* seen in this study, were greater than 3 dm tall and had cernuous/campanulate flowers. Turner (1992) inadequately characterized this species in his key to the section *Anticlea* and distinguished *Z. volcanicus* on the basis of tepals 14–15 mm long at anthesis. His description was obtained from a single Guatemalan specimen (*Beaman 3097 TEX*), which represented either an extreme variation or undescribed species with very large flowers that are not at all typical of *Z. volcanicus*. Duplicates of this unusual collection (*Beaman 3097 US* and *MSC*) have somewhat smaller tepals (12–13 mm long), less paniculate inflorescences, and a strong resemblance to *Z. mogollonensis*. However, *Z. mogollonensis* is readily distinguished from it by its purple flowers and occurs 3,000 km north of the Guatemalan plant.

The type specimen and original description of *Zigadenus volcanicus* (Bentham 1842) represented a species with tepals 6–8 mm long. Standley and Steyermark (1952), from an independent collection (*Steyermark 50153 US*) for their *Flora of Guatemala*, agreed with Bentham (1842). Baker (1879) recognized *Z. volcanicus* as a cernuous-flowered species and distinguished it from *Anticlea mexicana* Kunth (= *Z. virescens*) by its somewhat broader tepals. Many of the specimens of *Z. volcanicus* that we studied could be further distinguished from *Z. virescens* by their longer bracts (often as long or longer than the pedicels) and stamens that are shorter than the tepals. The combined features of broader tepals and longer bracts also describe *Z. porrifolius*



and *Z. hintoniorum* (both = *Z. virescens*). Like *Z. elegans*, bract length was not consistent in *Z. volcanicus* and varied from one-half to two times the length of the pedicel. Bract length in *Z. virescens* is also variable, but is usually less than the length of the pedicel. Other distinguishing, but inconsistent, features of *Z. volcanicus* were noted in this study. Several specimens displayed a wavy, and often twisted, central axis of the inflorescence. The flowers were often clustered at the ends of long panicle branches. The significance of these characteristics must wait for the collection and study of additional specimens.

The variation in *Zigadenus volcanicus* suggests that it may be further divisible, at least at an infraspecific level, and it is tempting to name the large-flowered form on the Sierra de los Cuchumatanes in northern Guatemala. However, in several collections from that location, the tepals range in length from an extreme 15 mm to the 7 mm of the more typical form. One collection (*Steysmark 50317 F*) from Sierra de los Cuchumatanes is a mixed sheet containing a plant with tepals 10 mm long and another 7 mm long. Further collections and field studies are necessary before a large-flowered taxon can be separated from *Z. volcanicus*.

The following key to the taxa in *Zigadenus* section *Anticlea* accepts a broad concept of species variability and, therefore, somewhat artificial limits of taxon circumscription. The most ambiguous separation occurs between *Z. virescens* and *Z. volcanicus*. *Zigadenus hintoniorum* will mostly key out to *Z. virescens*, but because there is no consistent and distinguishing criterion for *Z. hintoniorum*, it may also key to *Z. volcanicus*. We prefer to extend the limits of variation for *Z. virescens* and the geographic distribution of *Z. volcanicus* rather than continue the use of a new and variable taxon that cannot be separated from existing species. Also, *Z. porrifolius* (= *Z. virescens*) in southeastern Arizona will occasionally key to *Z. volcanicus*. We suspect it is the result of intergradation with *Z. elegans*, and not because of a relationship to *Z. volcanicus*.

#### KEY TO THE AMERICAN TAXA IN *ZIGADENUS* SECTION *ANTICLEA*

1. Pedicels erect at anthesis; corolla rotate to rotate-campanulate; plants of United States and Canada with sporadic populations in northern Mexico.
2. Lower stem sheathed with numerous hard, persistent leaf bases; tepals 4–8 mm long; plants of hanging gardens on cliffs in southeastern Utah ..... *Z. vaginatus* (Rydb.) J.F. Macbr.
2. Old leaf bases not persistent; tepals 5–10 mm long; plants widespread.
  3. Inflorescence usually racemose, occasionally with one or a few erect panicle branches in the lower inflorescence; plants of western N. America ..... *Z. elegans* Pursh var. *elegans*
  3. Inflorescence usually paniculate with a few to several lax branches, rarely racemose, plants of eastern N. America ..... *Z. elegans* var. *glaucus* (Nutt.) Preece



1. Pedicels decurved or widely spreading, attached to cernuous flowers at anthesis; corolla campanulate; plants of Arizona, New Mexico, Mexico, and Guatemala.
4. Tepals 4–10 mm long at anthesis.
  5. Stamens usually as long or longer than the tepals; tepals 1.5–3.5(4) mm wide and < 8 mm long; floral bracts usually shorter than the subtended pedicels ..... *Z. virescens* (Kunth) J.F. Macbr.
  5. Stamens shorter than the tepals; tepals 3–6 mm wide and > 6 mm long; floral bracts  $\frac{1}{2}$  to longer than the length of the subtended pedicels ..... *Z. volcanicus* Benth.
4. Tepals 12–16 mm long at anthesis.
  6. Tepals greenish with pale to dark purple margins; plants of conifer forests in the Mogollon Mts. of SW New Mexico ..... *Z. mogollonensis*
  6. Tepals white to ochroleucous; plants of high alpine meadows on the Sierra de los Cuchumatanes of N. Guatemala ..... cf. *Z. volcanicus*

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## BOOK NOTICE

DE WAAL, LOUISE C., LOIS E. CHILD, P. MAX WADE, and JOHN H. BROCK (Eds.). 1994. **Ecology and Management of Invasive Riverside Plants.** (ISBN 0-471-94257-X, hbk.) John Wiley and Sons Ltd., Chichester, West Sussex, P019 1UD, England. \$95.00. 217 pp.

This book, one in the "Landscape Ecology" series, seeks to bring together researchers and practitioners to solve plant invasion problems. Considering the fact that many different habitats are invaded by non-indigenous plants, I was somewhat intrigued why the riverside habitat was chosen. The preface provides scant information on this problem; the only clue offered is that the river environment is "especially prone to invasion." Among the 20 chapters, all concerned with plants that grow in or near rivers, 11 deal with control methods; 6, with basic biology of weeds; and 3, with rates of spread. Data from the Czech Republic, Denmark, England, Ireland, Scotland, Sweden, western United States, and Wales are presented. The book provides much information for the practitioner wanting to eliminate weeds. However, it not much use for those wanting to understand how and why riparian environments are invaded. Furthermore, there is scant information about the potential ecological functions of non-indigenous plants in riverside habitats.—*James O. Luken.*